Helium Isotope Compositions in Springs from the Three Sisters Region, Central Oregon, USA.

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The Three Sisters region has recently come under increased scrutiny after the discovery by Satellite Radar Interferometry (InSAR) of a broad area of uplift centered approximately 5 km west of the South Sister volcanic edifice (Wicks et al., 2001). The bulge, which at its center reaches a maximum of 10 cm, formed between 1998-2000. The exact cause for the uplift is unknown, but observations from other volcanoes and results from numerical modeling imply that the most likely cause is the movement of magma up to mid-crustal (~6.5 km depth) levels (Wicks et al., 2001).

The area of uplift coincides with an area where spring chemistry shows anomalously high levels of chloride and carbon emissions (Ingebritsen et al., 1994). These features pre-date the bulge by at least a decade and can also be indicative of a magmatic source. It is unclear if the bulge and the geochemical anomalies are directly related, but both point to the presence of magma below the Three Sisters area.

Within the scope of a monitoring project that has recently been initiated to study the development of the bulge and any accompanying changes in the fluid/gas chemistry of springs in the Three Sisters area, 10 gas samples were collected for noble gas analysis in July 2001. Two of these samples were taken from cold bubbling springs located close to the center of the bulge and the remaining 8 were obtained from well documented geothermal springs within the general area of Central Oregon.

Helium isotope ratios (reported as R_c/R_a where R_c = air corrected $^3He/^4He_{sample}$ and R_a = $^3He/^4He_{air}$ for these 8 samples range from 2.8 to 5.1 R_a which is in agreement with existing data reported in a study carried out by Unocal in the early 1980's of geothermal springs in this area. The data show a relationship with distance to the bulge/South Sister volcano: all samples within a radius of ~30 km have helium isotope ratios in the range of 4.5 – 5.1 R_a, while samples that fall outside this radius have distinctly lower helium isotope ratios (<4 R_a).

The two samples from the center of the uplift area have helium isotope ratios that are significantly higher (7.4 and 8.6 R_a) than the data for the other springs. This clearly demonstrates the presence of a mantle derived magma at some depth below the bulge and the occurrence of permeable pathways to the surface for gas of magmatic origin.

At this time, due to a lack of literature noble gas data for the exact area of the bulge, it cannot be determined if the occurrence of these high ratios, which are a common feature

in other Cascade Range volcanoes, coincided with the formation of the bulge or if they predate the uplift. This remains a subject for further study.

Wicks, C. Jr., Dzurisin, D, Ingebritsen, S. E., Thatcher, W., Lu, Z., and Iversen, J. (2001) Magmatic activity beneath the quiescent Three Sisters volcanic center, central Oregon Cascade Range, USA, abstract AGU Fall meeting, this volume

Ingebritsen, S. E., Mariner, R. H., and Sherrod, D. R. (1994) Hydrothermal systems of the Cascade Range, North-Central Oregon. USGS Professional paper 1044-L 88p.

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